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Holographic evanescent-wave focusing with nanoparticle arrays

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Abstract

Three-dimensional focusing of evanescent waves by specially configured surface arrays of nanoparticles emulating near-field optical holograms of dipole sources (located close to the surface) is suggested and analyzed. The idea is to place chains of nanoparticles along bright fringes of calculated (holographic) interference patterns so that the local nanoparticle density along these chains would be proportional to the local intensity contrast in the interference patterns. Three different configurations are considered: a holographic scheme with totally internally reflected reference and reconstructing waves, a modified scheme with the reconstructing wave being represented by a suitable surface plasmon polariton (SPP) plane wave, and a SPP holographic scheme with reference and reconstructing waves both being (phase-conjugated) laterally-confined (Gaussian) SPP beams. Our numerical approach is based on the Green's function technique with the point-dipole approximation for radiation scattering by nanoparticles. We demonstrate that a nanoparticle array configured in accordance with the intensity interference pattern formed by a dipole field and a reference wave allows one to efficiently focus the (phase-conjugated) reconstructing wave (via its scattering by the nanoparticle array) at the site of the dipole. Influence of the polarization and wavelength of the reconstructing wave on the resulting intensity distribution is also considered. Fabrication of suitable nanoparticle arrays is discussed along with their potential applications.

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